



An Energy Efficiency Workshop & Exposition

Palm Springs, California

Protecting Air Quality in the Workplace



Henry M. Healey, P.E.

Healey & Associates

Merritt Island, Florida

<http://www.flaenergy.com>

©Henry M. Healey, P. E.



Indoor Air Quality

(“Environmental” or “Air” Quality issues?)

□ Environmental Quality

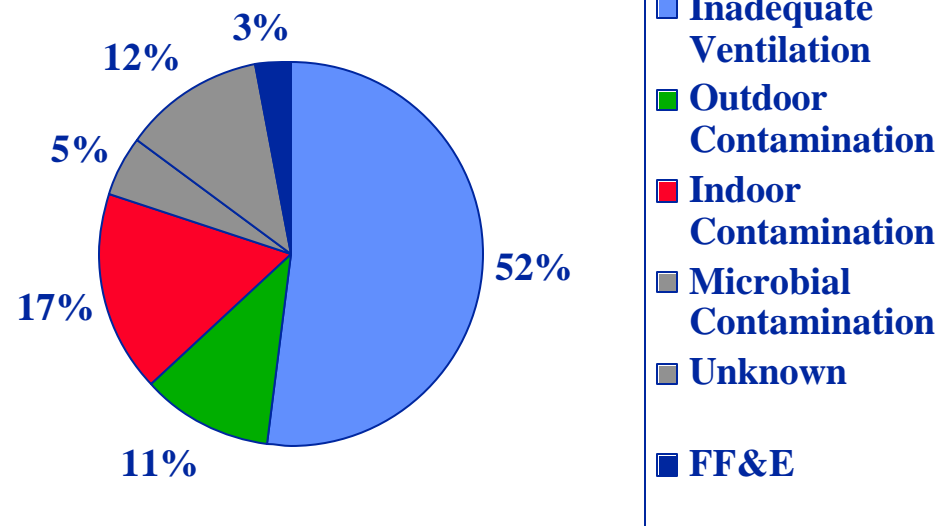
- Air Quality
- Lighting
 - frequency
 - glare etc
- Noise
- Workplace conditions
 - Workplace Layout
 - Interior Design
- Other

□ Air Quality Issues

- Temperature
- Humidity
- Contaminants, odors, pollutants etc.
- Visible deposits
- Mold mildew
- Air movement

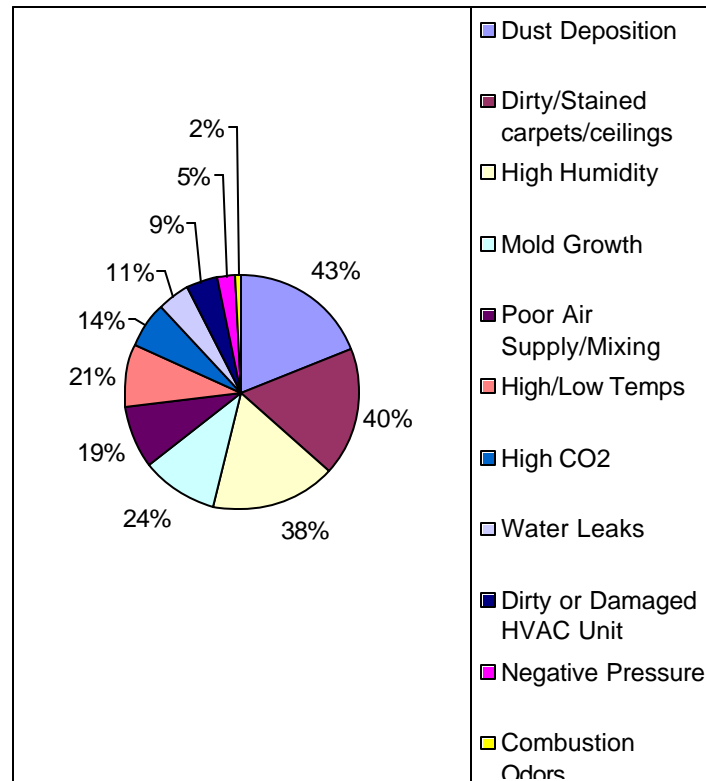


Causes of IAQ Problems NIOSH Study





Findings in Buildings with Reported “IAQ” Problems



June 2-5, 2002

Henry M. Healey P.E.



Major Contributors to IAQ Problems

- **Building envelope & maintenance**
 - air leaks (uncontrolled entry of outdoor air)
 - water or moisture intrusion
 - Housekeeping & HVAC maintenance procedures
- **Contamination**
 - indoor or outdoor sources
 - build up of contamination
- **HVAC System**
 - air distribution
 - humidity control
 - filtration
 - insufficient ventilation (air turnover)



Findings in Buildings with “IAQ” Problems

- ❑ Humidity extremes resulting in mold and mildew
- ❑ Poor Air Distribution
- ❑ Building envelope problems
- ❑ Indoor pollutants and/or off-gassing of materials
- ❑ Not enough, or poor quality of, fresh air
- ❑ Contamination from exterior sources
- ❑ Housekeeping and maintenance issues
- ❑ Incidents



What should we do to address IAQ Problems?



Focus on Humidity, Contaminants and Air Quality

- **Improve (Lower) humidity levels**
 - Address water leaks in, or into, building **immediately**
 - Prevent or reduce infiltration of humid air
 - Add Controls for humidity
 - Precondition (dehumidify) fresh air before it enters HVAC
- **Reduce contaminants**
 - Improve filtration and ventilation (ACH)
 - Improve housekeeping & maintenance
 - Monitor what's brought inside
- **Check air distribution and fresh air**
 - Sufficient air movement throughout space
 - Sufficient fresh air to meet ASHRAE 62 and pressurization



Most Serious IAQ Problems are Moisture Related

- Air leaks in building envelope or ductwork results in the entry of moist unconditioned air
- Water intrusion and/or moisture migration through the building envelope
- Oversized AC system limits moisture removal
- Spores are everywhere in our environment

Humidity levels above 60%-70%
will result in microbial growth!



An Energy Efficiency Workshop & Exposition

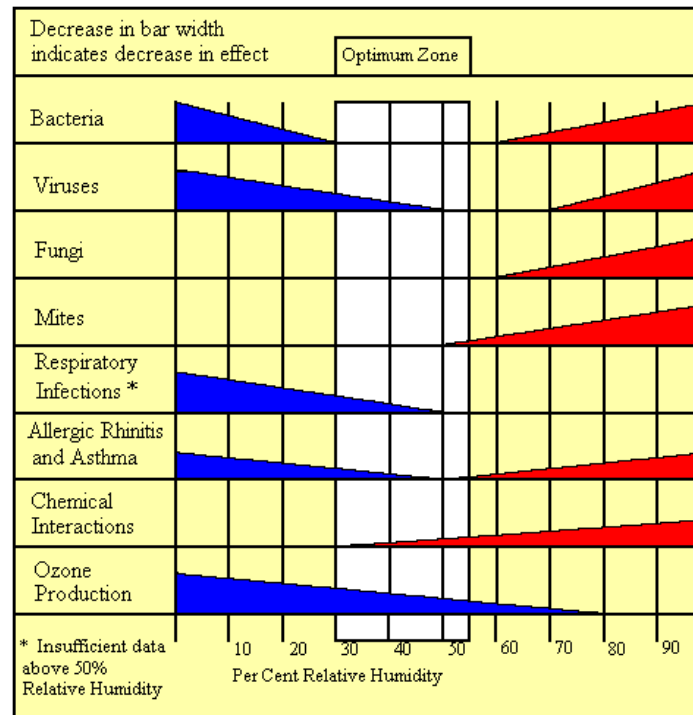
Palm Springs, California

***To Ensure Good IAQ
Relative Humidity Levels
Must be Maintained
within an Acceptable Range***

Optimum Range: 40%-60% RH



Optimum Relative Humidity Levels

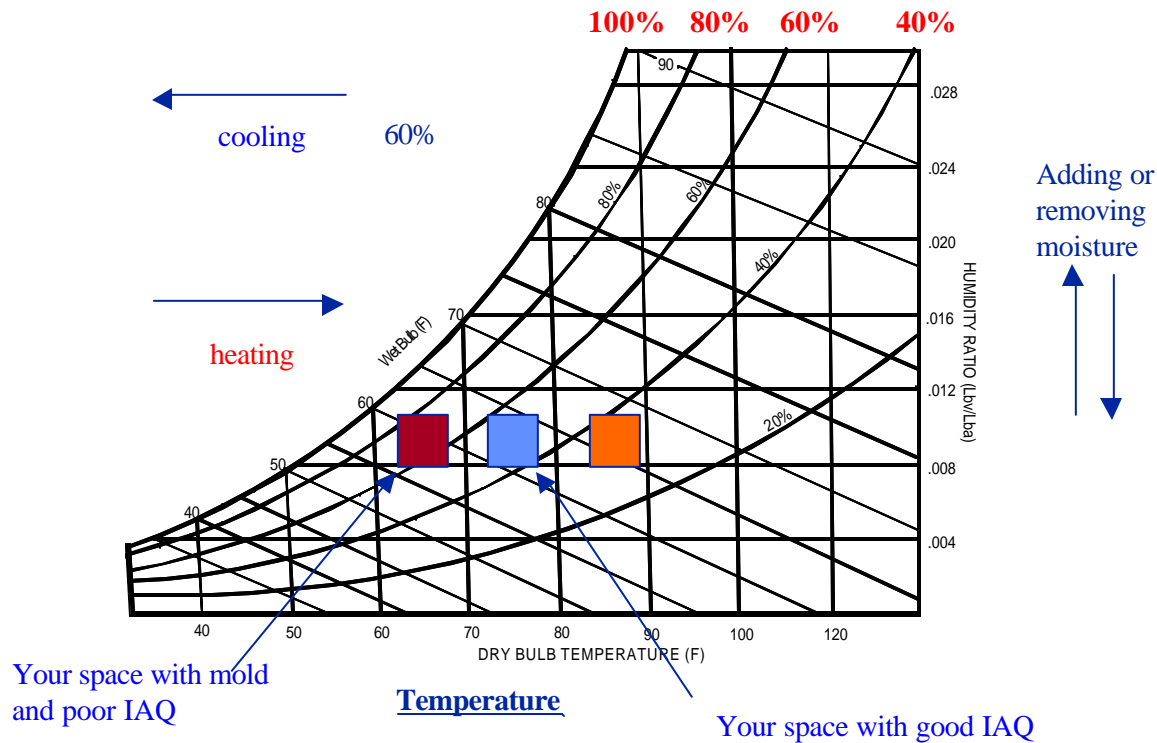




Psychrometric Chart

Moisture Content of Air

temperature Vs. relative humidity



June 2-5, 2002

Henry M. Healey P.E.

12



Address Humidity Levels

- Why do we have high Humidity in buildings?
 - air or water leaks into building
 - poorly performing HVAC system
 - no real control of humidity
 - Improper operation of HVAC system
 - Oversized unit
 - etc.
- How can address high humidity levels easily?
 - Eliminate water or air leaks or intrusion immediately
 - Add humidity control & reheat strategy
 - Reduce or eliminate the moisture load from the building



Reduce Contaminants

- By cleaning and exchanging indoor air
 - Proper Filtration
 - Appropriate for the contaminants
 - Good Air Distribution
 - Adequate air movement throughout Work Area
 - Adequate turn-over of indoor-outdoor air (ACH)

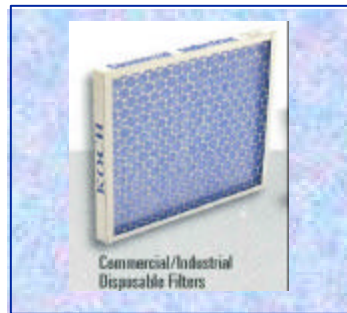


Proper Filtration

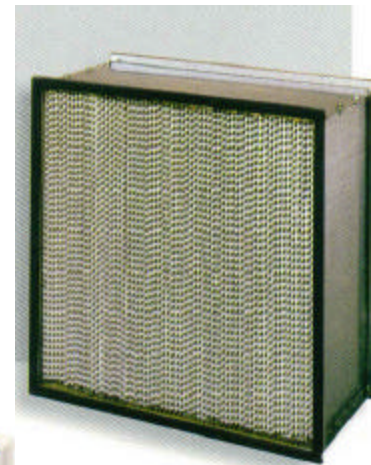
(filters come in all shapes all sizes)



Pleated Filter



If you can see through a filter-
it's not a filter



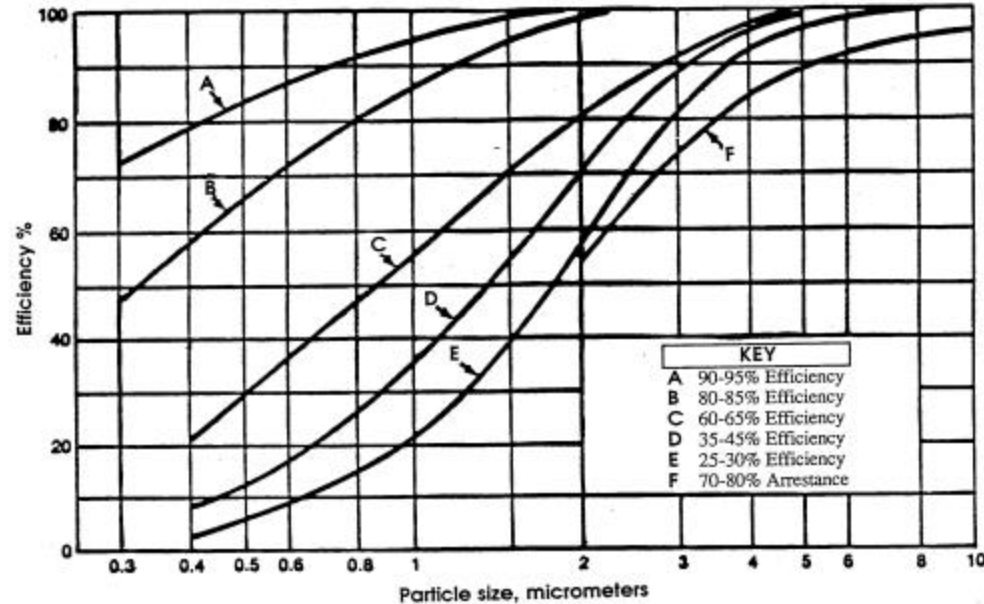
HEPA Filter

99.97% of 0.3u



Relative Performance

Efficiency vs. Particle Size



***Notes:**

1. Compiled and averaged from data furnished by manufacturers.
2. Efficiency and arrestance per ASHRAE standard 52-76 test methods.
3. **Caution:** Curves are approximations only for general guidance. Values derived from them must generally be used to specify air filters since A.



Filter Efficiency Rating

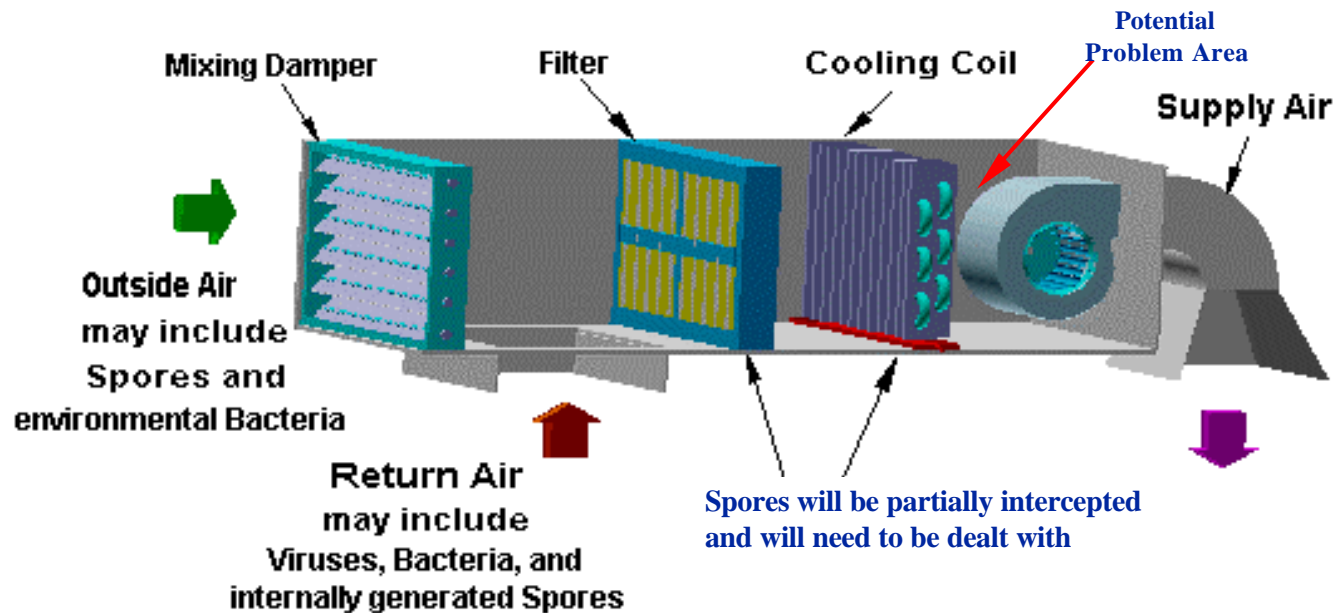
(Minimum Efficiency Rating Value-MERV)

Minimum Efficiency Reporting Value (MERV)				
MERV	ASHRAE	P Dp	Contamnts	Application
1	<65% A	0.3	Poln Moss	Min Fltr
2	65-70%A	0.3	D Mites	W AC
3	70-75%A	0.3	T Fibers	Res
4	>75%A	0.3	Carpet fbr	Res
5	80-85%A	0.6	Pdr milk	Paint Booth
6	>90%A	0.6	Dust	Industrl
7	>90%A	0.6	H Spray	B Res
8	>90%A	0.6	M spores	Coml
9	40-45%DS	1	fumes	Coml
10	50-55%DS	1	coal dust	S Res
11	60-65%DS	1	flour	Btr Cml
12	70-75%DS	1	Legionella	Labs
13	80-90%DS	1.4	Copiers	Sup Cml
14	90-95%DS	1.4	smoke	Smokg A
15	>95%DS	1.4	sneezing	Surgery
16	N/A	1.4	bacteria	Hosptl



HVAC Equipment

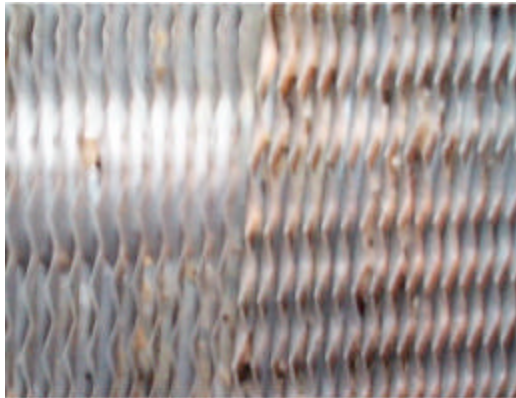
(potential source of contamination)





HVAC System Contamination

**Cooling Coil With
Microbial Growth**



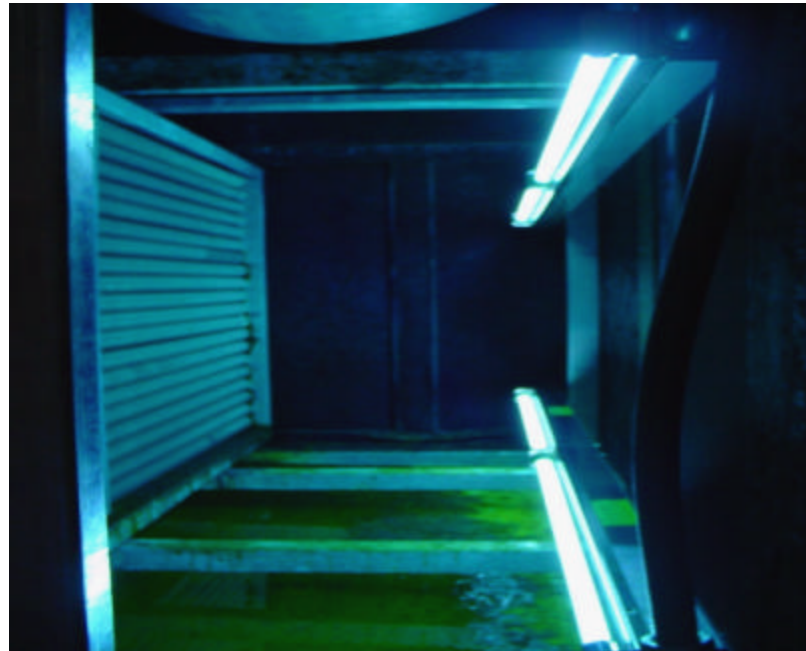
**Drain Pan With
Microbial Growth**



- **Cooling coils and drain pans provide ideal growth conditions for microbes.**
- **Cooling Coil surfaces are coated with this “biofilm” that reduces heat exchange efficiency thus consuming more energy.**



UVGI Installation



**Typical UV Light Installation In Air Discharge Plenum Cooling Coil
located to work on both the cooling coil and the drain pan**

June 2-5, 2002

Henry M. Healey P.E.



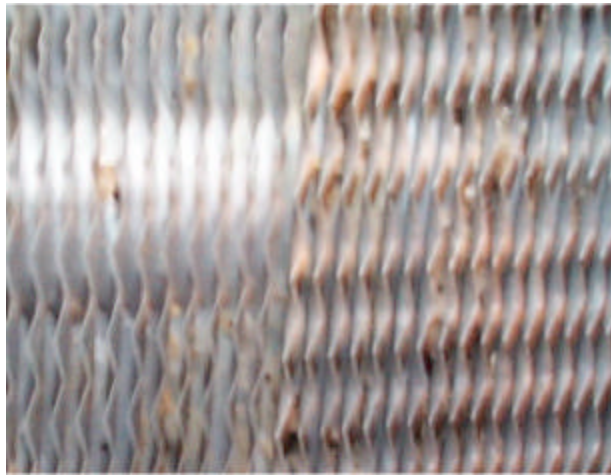
UV Recommendations

- Suitable for keeping problem drain pans, interior of AHU, and coils clean
- Can combine with filtration to increase effectiveness against biological contaminants

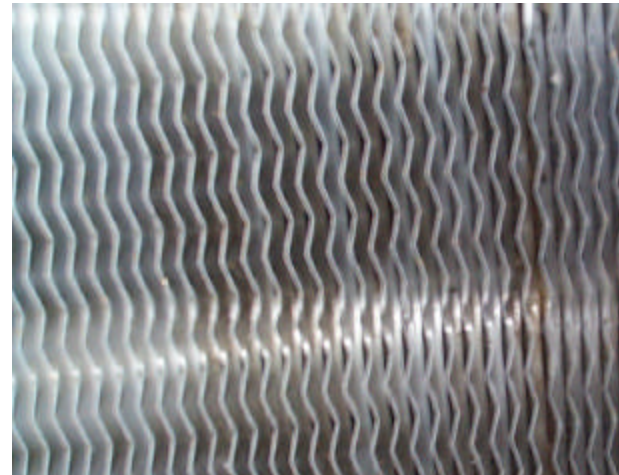


UVGI Treatment

Before installation of UV



After UV Installation



Installation of UV resulted in the elimination of virtually all the organic matter embedded within a coil restoring the coil surface for increased heat exchange efficiency. The installation also eliminated growth in drain pan.



Good Air Distribution

- Adequate air movement throughout the space
 - Air Flow in the Workspace (cfm/sf)
 - Distribution System (supply/return layout)

- Adequate turn-over of indoor-outdoor air (ACH)
 - Ventilation Rate-amount of fresh air (ASHRAE 62)

- Building pressurization



Adequate Fresh Air

(without getting in a bind)

- Sufficient for Air Change Rate (ACH)& occupants
 - ASHRAE (Code) requirements
- Sufficient to offset air losses
 - Exhaust fans
 - leakage through doors, windows, cracks etc.
- Sufficient for appropriate pressurization
 - Climate specific
 - Positive in warm/humid climates
 - Neutral or slightly negative in cool climates
- Eliminate or reduce fresh air when not required
- Simply adding fresh air may be problematic

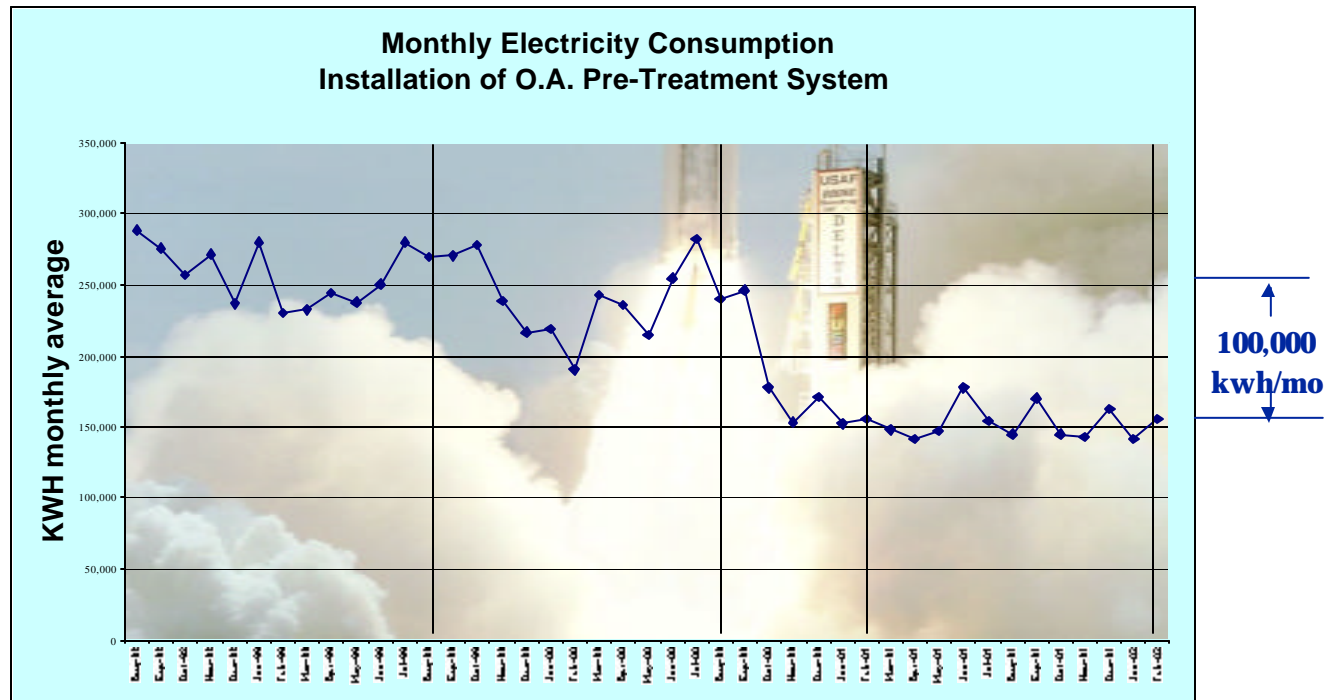


Pre Treating Outdoor Air

- Preconditioning, dehumidifying and filtering, the Outdoor Air is a simple, energy efficient solution to the humidity and comfort problems faced by most building managers today.
- This approach essentially removes moisture in the outdoor air, and its associated impact on internal humidity levels, as an issue and promotes efficient operation of a buildings HVAC system



Energy Savings from OA Pre-Treatment Installation



June 2-5, 2002

Henry M. Healey P.E.

26



An Energy Efficiency Workshop & Exposition

Palm Springs, California

Indoor Air Quality and Energy Conservation

Are Not Mutually Exclusive!

We Can Improve IAQ, Save Energy and
Protect the Building's Occupants



An Energy Efficiency Workshop & Exposition

Palm Springs, California

Protection of Air Quality in the Workplace



Henry M. Healey, P.E.

Healey & Associates

<http://www.flaenergy.com>



An Energy Efficiency Workshop & Exposition

Palm Springs, California

***Protecting
Workplace Air Quality
Today-Post 9/11***

Considering Bioterrorism
and other
Extraordinary Incidents



Bioterrorism

***Has raised the issue of
Air Quality in Buildings to a whole new level***

Building Security, Health & Safety Programs today
must include provisions for
***Protecting and reacting to threats
to the Indoor Air from
Biological & Chemical Terrorism & other
Extraordinary Incidents***



Bioterrorism

Use of biological agents including
bacteria, viruses and toxins
against the general population

- Anthrax
- Smallpox
- Plague
- Botulism
- Terramin
- Others





Extraordinary Incidents That Impact IAQ

- Accidents
 - Toxic Clouds or Releases
 - Hazardous Spills
 - Sudden Explosions
- Forest Fires
- Air Pollution Alerts
- Natural Disasters



Safety & Security of Building Air Quality

**Must Protect Building Occupants from
Airborne Biological, Chemical or Toxic
Releases Outside or Inside a Building
Caused by Terrorism, Accidents
or Natural Disasters**



Protecting Building Occupants from Airborne Biological or Chemical Releases Outside or Inside a Building

- **Hazards include:**
 - Hazardous fumes
 - smoke from fires
 - chemicals from explosions or other incidents
 - Noxious chemicals
 - spills or releases
 - Biological aerosols or particles
 - incidents
 - intentional release



Bioterrorism Incident

- No immediate impact or detection
- Hours of potential exposure
- Delay between exposure and illness
 - Anthrax symptoms takes days
 - smallpox takes longer-weeks
- Requires advanced and emergency planning
 - to increase security of a buildings air supply
 - to control and/or minimize impact of incident



Personal Observations

(a matter of being in the wrong place at the wrong time)

- Suspicious package found
- Put in envelope to contain contents
- Called Emergency personnel
- Building Locked down until Responders on site
- Occupants rather edgy
- HVAC left running
- Two hours later Darth Vader appears in building
- Testing initiated-Field Test Negative (lab test within 24 hrs)
- Occupants allowed to leave & shower
- Not happy campers



Personal Observations on Bioterrorism Training

- Responder Training Great
- Most Training focused on Response Actions & Procedures, Testing, Detection and Disinfection
- Little Effort in Awareness and Safety Training for Building Managers and Occupants
- Development of Building Air Quality Protective Systems progressing very slowly



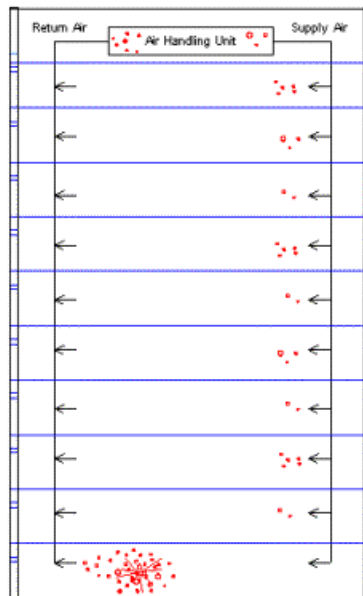
Anthrax Incidents Lessons Learned

- Airborne materials can easily spread
- Appropriate Cleanup Procedures should be used
- There is a lot of readily available strategies that can be used to limit exposure and/or impact
- Quick action by those on site can make a difference



Anthrax Incidents

Explosive dispersal into Return or Outdoor air intake



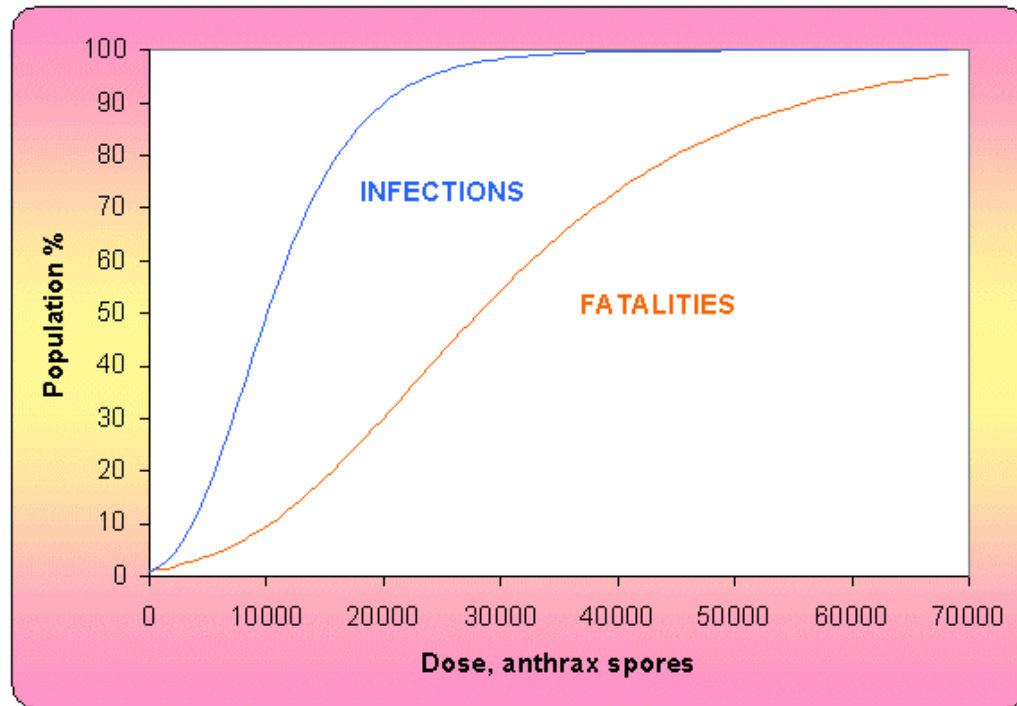
Release



Exposure

Infection Dose-10,000

Lethal Dose-28,000 (50%)



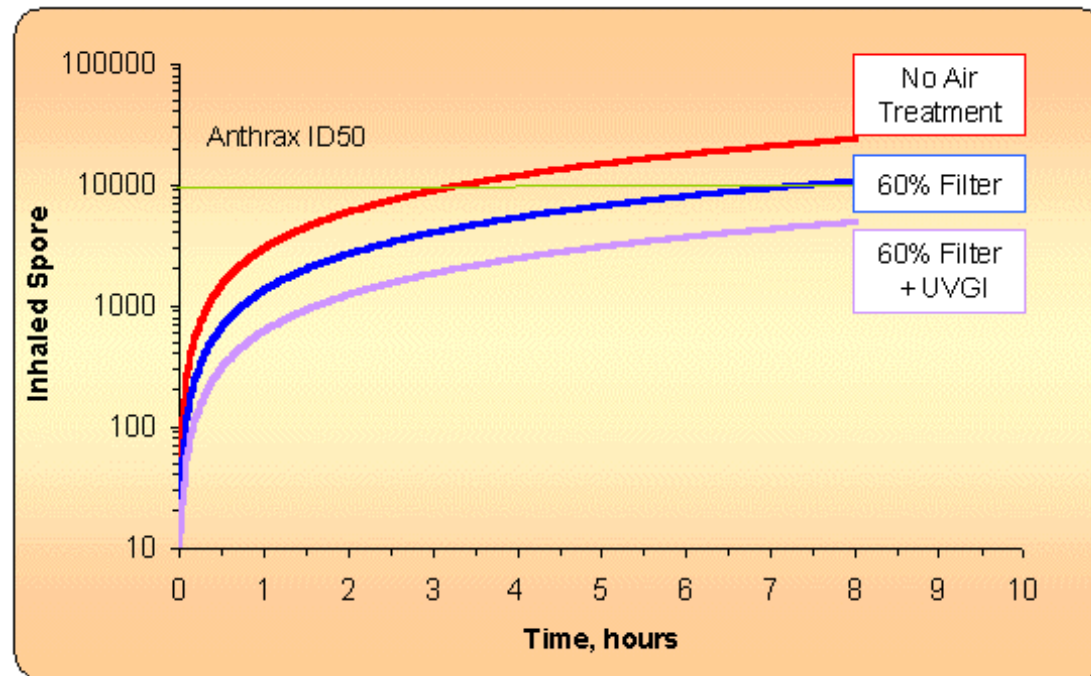
June 2-5, 2002

Henry M. Healey P.E.

40



Level to infect 50% of those Exposed



June 2-5, 2002

Lethal dose for 50% -28,000 spores
Henry M. Healey P.E.



Airborne Hazards

(Biological, Chemical or Other Incidents)

- Biological & Chemical
 - Detectors not available that can rapidly detect the range of Chemical or Biological hazards possible
 - Biological agents imperceptible, difficult to detect
- Extraordinary Incidents
 - Sudden & unexpected
 - often perceptible at occurrence
- Protection needs to be in place
 - Standard approaches
 - filtering air into a building
 - emergency air distribution controls
 -other

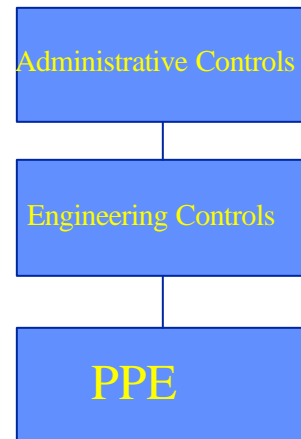


Reduce the Terror with Planning

- Develop a **BAQ Safety Program** with appropriate policies and procedures
- Train occupants and facility managers
 - proactive security measures
 - safety procedures
 - response actions
 - appropriate work & cleanup procedures
- Implement “engineering controls” to secure and protect building air quality
- Use PPE as required in critical areas



BAQ Safety Program





Safety Program Plan

- Identify potential hazards and air quality problems
- Assess buildings vulnerability to airborne threats
 - Internal releases
 - External releases
- Develop appropriate response actions and training
- Evaluate use of engineering controls to reduce threats
- Identify appropriate PPE as required



Assessing BAQ Safety & Security

- Assess Vulnerabilities
 - Air intakes
 - Receiving areas
 - Entry areas
 - Hazardous material labs/storage
- Ventilation System
 - Supply & return & exhaust systems
 - Make up air quality/quantity
 - Filtration
 - Operational controls
- Review existing Safety Programs



Occupant Training

- Awareness Training on IAQ
 - Understanding IAQ and the necessity to report potential problems
 - Avoid contributing to the problems with deodorizers, chemicals etc.
 - Reporting potential problems
 - Avoid blocking ventilation pathways
- Training related to Extreme Incidents



Conduct a Vulnerability Assessment of the Building

- Hazard assessment
 - Sources of entry
 - Areas of potential contamination
- Ventilation system and building pressurization
 - air intakes
 - exhausts
 - relative pressurization
 - areas served by HVAC units
 - HVAC system controls
- Interior safe rooms



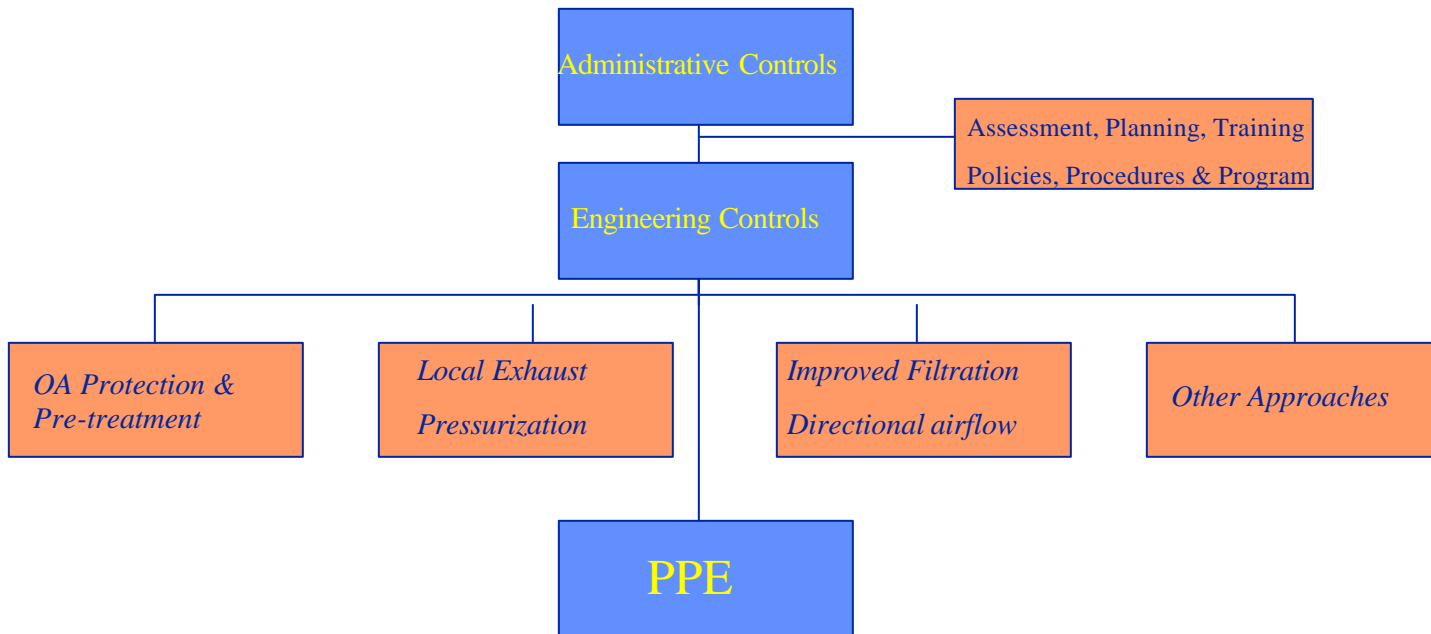
Engineering Controls

- Elevate/Secure Outdoor Air Intakes
- Isolate Entry and Receiving Areas
- Control Dampers to seal buildings
- Outdoor Air Pretreatment System
- Operational Control of HVAC equipment
- Enhanced filtration
- HEPA exhaust systems
- Reconfigure HVAC in hazardous work areas
- Other as appropriate for the site



BAQ Safety/Security Plan

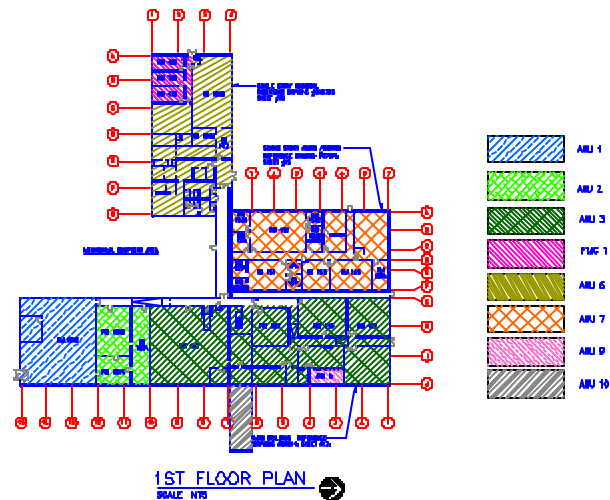
pro-active BAQ





Ventilation System

- What AHU serves the impacted area
- How can it be shut down
- Where is the closest exhaust system





BAQ Protective Approaches

(Engineering Controls)

- Protection of fresh air intakes
- High efficiency filtration of “high risk” areas
- Building Pressurization
- Dedicated OA units
 - secure locations
 - with control dampers
- Directional airflow
 - Laboratory
 - Isolation/clean room approach



OA Pre-Treatment System

(addresses IAQ while reducing energy)

- **Dedicated “OA” Pre-Treatment Unit**
 - 100% OA Unit(s) to provide all fresh air to a building
 - OA system will be designed to filter & dehumidify all air entering a building air and maintaining pressurization in the building to eliminate the entry of untreated outdoor air
- **OA and Exhaust Control Dampers**
 - Controllable Dampers to eliminate OA and Exhaust leaks and seal the building during unoccupied periods or in the event of threats from outside the building
 - **DDC Controls to provide**
 - for Safety and health hazard mitigation
 - operational and humidity control of building
 - centralized control of entire HVAC System
 - optimum efficiency of HVAC System



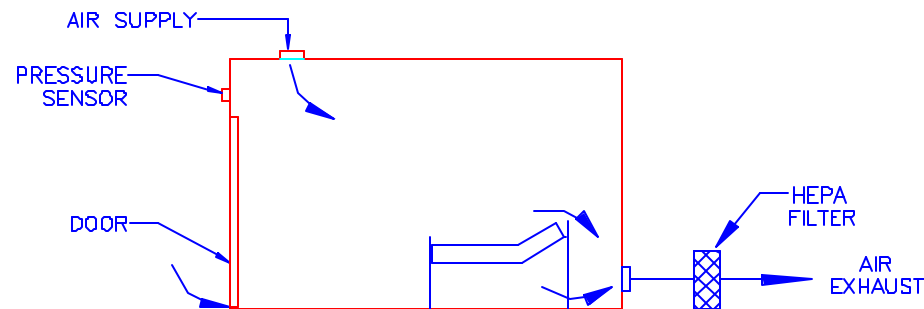
Bioterrorism in Buildings Readily Addressed

- Release of biological or chemical hazards in (or into) buildings
 - Engineers and HVAC designers routinely deal with toxic materials in industrial, laboratory or medical facilities
 - Particle size in the range 1 to 5 microns
 - Filtration, containment, air flow control and pressurization are key.
 - Asbestos abatement, Laboratory Safety, IAQ and Biohazardous material handling and related programs and procedures are proven and readily available.



Typical Isolation Room

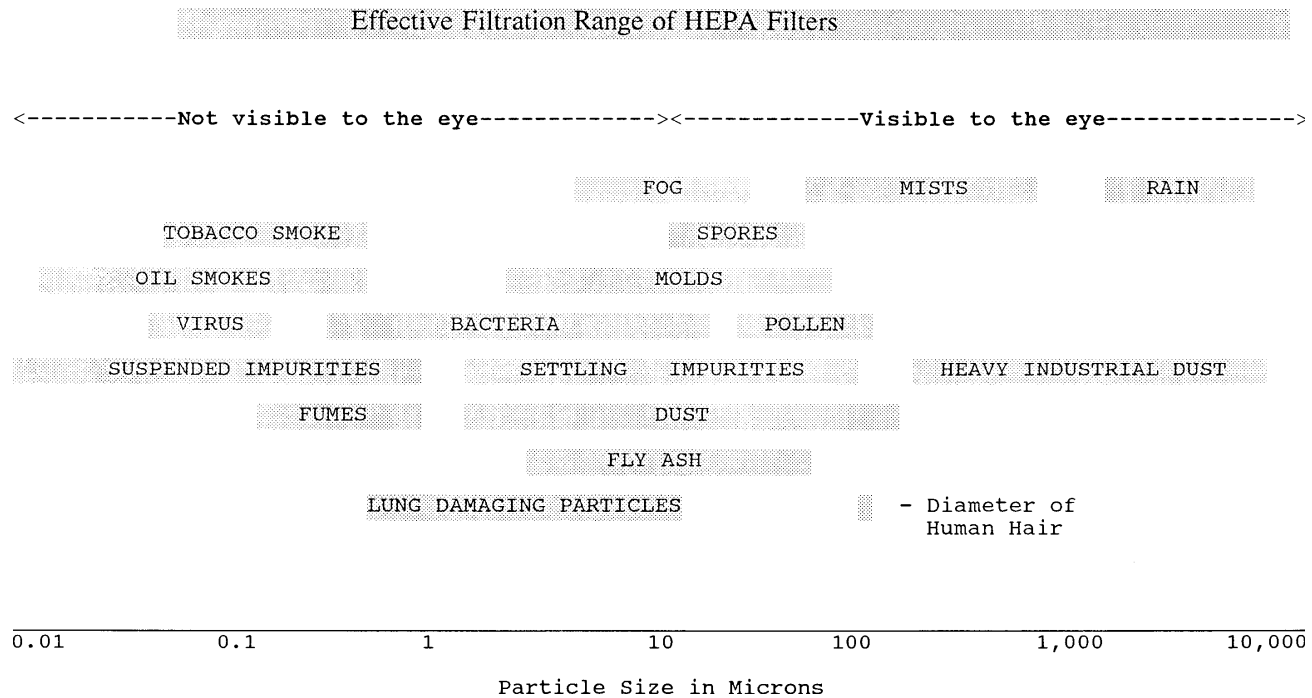
(Directional airflow)





HEPA Filtration

RELATIVE SIZE OF COMMON AIR CONTAMINANTS





Mailroom Sorting Area Upgrade

- Isolation Room approach (negative with respect to surrounding area)
- Directional airflow (lab or cleanroom approach)
 - from above
 - over breathing zone
 - then work area
 - low exhaust (could be filtered)
- PPE readily available



Cleanup

- Procedures appropriate for the contaminant
- Decontaminate using ACM approach (Negative Pressure Machines), Disinfectants, PPE as reqd.
- Vacuum cleaners equipped with High Efficiency Particulate Air (HEPA) filters should be standard



Incorporating BAQ Protection into New Construction

- Outdoor Air
 - Intakes above ground (first floor) level
 - Pre conditioning unit with controls & dampers
 - Security & monitoring
- HVAC
 - upgraded filtration, UV, pressurization, zone strategy
 - Emergency Shutoff
 - Zone Isolation for High Risk Areas
 - Entry Areas
 - Receiving Areas
 - Mail Rooms
- Physical Location of High Risk Areas Perimeter of building



*Building Air Quality can protect
against Bioterrorism and Extreme
Incidents (to some extent)
using readily available solutions to
IAQ*



*I think the Time come to address IAQ
Problems and Protect Air Quality in the
Workplace!*

What do you think?

Thanks for listening

Henry M. Healey, P. E.

<http://www.flaenergy.com>